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# New dinosauriform (Ornithodira, Dinosauromorpha) record from the Upper Triassic of Southern Brazil

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## Introduction

Dinosauriformes includes the most recent common ancestor of *Marasuchus lilloensis* and Dinosauria, and all taxa stemming from it (Novas, 1992). The origin of this group and its diversification have been the subject of extensive studies in recent years (Langer *et al.*, 2010; Langer *et al.*, 2013), especially because it includes the dinosaur lineage, one of the most diverse groups of Mesozoic tetrapods (Irmis, 2011; Novas *et al.*, 2011). The oldest Dinosauriformes came from the upper Anisian of Tanzania (Nesbitt *et al.*, 2010) and the Ladinian of Argentina (Romer, 1972a, b; Arcucci, 1987; Sereno and Arcucci, 1993) and recent studies demonstrated that non-dinosaur dinosauriforms shared environments with dinosaurs until the end of the Triassic (Novas and Ezcurra, 2005; Ezcurra, 2006; Nesbitt *et al.*, 2010; Langer *et al.*, 2013). Yet, the small number of available specimens regarded as early members or possible ancestors of Dinosauria still brings great uncertainty regarding both origins and phylogenetic relationships of the group.

In the present contribution, we report the occurrence of a new non-dinosaur dinosauriform specimen from the Santa Maria Formation, a stratigraphic unit that congregates the oldest unequivocal dinosauriform records from Brazil (Colbert, 1970; Langer *et al.*, 1999; Kischlat, 1999; Da-Rosa *et al.*, 2006; Cabreira *et al.*, 2011), all of which are included within Dinosauria. One exception is the problematic *Teywasu barberenai* (Kischlat, 1999), considered *nomen dubium* by Langer (2004) and revised recently by Ezcurra (2012), which tentatively suggests a

silesaurid affinity.

*Institutional abbreviations.*—UNIPAMPA, Universidade Federal do Pampa, São Gabriel, Brazil.

## Systematic palaeontology

Archosauria Cope, 1869

Ornithodira Gauthier, 1986

Dinosauromorpha Benton, 1985

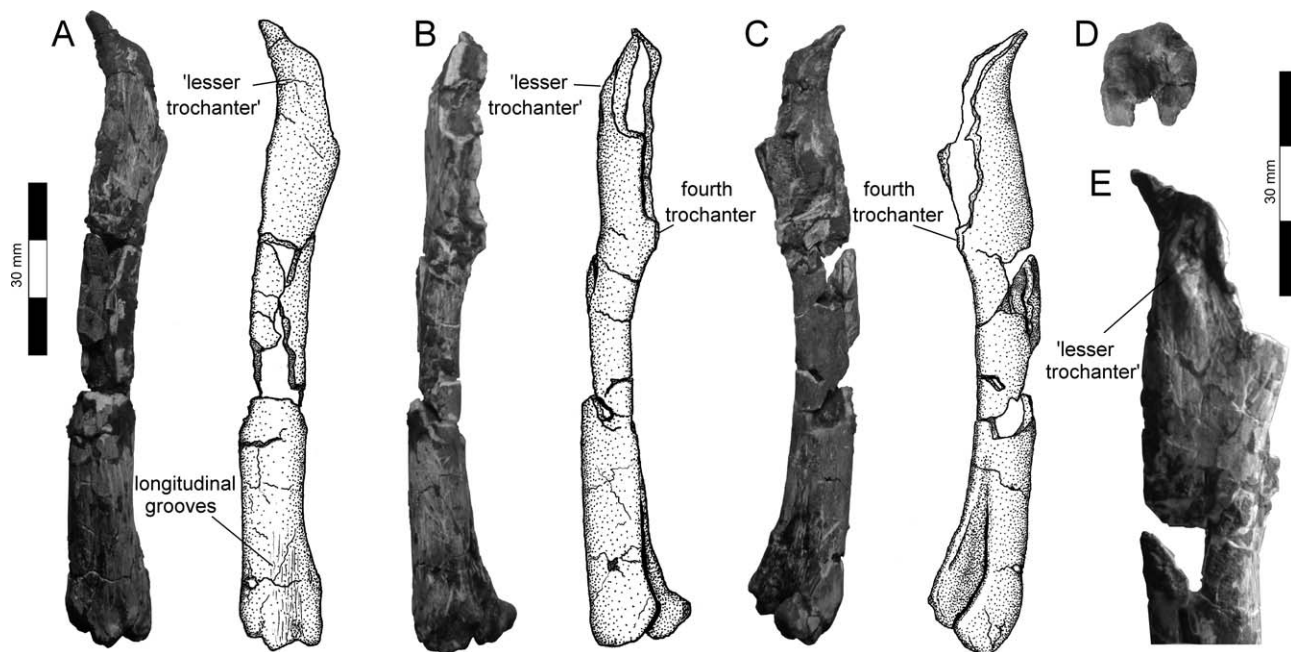
Dinosauriformes Novas, 1992

Figure 1

*Material.*—UNIPAMPA-0632, partial left femur.

*Locality and Horizon.*—Janner Site, 2 km west of Agudo, Rio Grande do Sul, Brazil. Upper portion of the *Hyperodapedon* Assemblage Zone (sensu Langer *et al.*, 2007), upper Carnian of the Paraná Basin.

*Description.*—The partial left femur is 110 mm long and sigmoid in cranial and lateral views. The proximal extremity is missing, and only the distal portion of the “crest-like” fourth trochanter is preserved (Figure 1B-C). The ‘lesser trochanter’ (*Musculus iliofemoralis cranialis* insertion) is seen on the lateral surface of the proximal half of the bone as a slight proximodistally elongated prominence that is completely connected to the shaft (Figure 1B and E). This condition differs from the knob-like ‘lesser trochanter’ of *Pampadromaeus barberenai* (Cabreira *et al.*, 2011), *Saturnalia tupiniquim* (Langer *et al.*, 1999), and *Sacisaurus agudoensis* (Ferigolo and Langer, 2007), in which the proximal portion is separated from the shaft by a cleft. The ‘trochanteric shelf’ is



**Figure 1.** Photographs and illustrations of specimen UNIPAMPA-0632. **A**, cranial view; **B**, lateral view; **C**, caudomedial view; **D**, distal view, and **E**, caudolateral view.

absent (Figure 1E), as in *Sacisaurus* and differently from *Pampadromaeus* and *Saturnalia*. The popliteal fossa extends for one-fourth to one-third of the shaft length (Figure 1C), as in *Asilisaurus kongwe* (Nesbitt *et al.*, 2010), *Eucoelophysis baldwini* (Sullivan and Lucas, 1999), *Silesaurus opoloensis* (Dzik, 2003), *Sacisaurus* and *Diodorus scytobrachion* (Kammerer *et al.*, 2012). Some longitudinal grooves can be observed along the cranial surface of the distal portion of the femur, which may correspond to points of insertion for the *Musculus femorotibialis externus* (Figure 1A).

### Discussion and conclusion

UNIPAMPA-0632 is assigned to Dinosauriformes due to the presence of a 'lesser trochanter' and a "crest-like" fourth trochanter. It does not bear any clear autapomorphic character, but differs from all previously known dinosauriforms from the Santa Maria Formation due to the combination of a 'lesser trochanter' completely connected to the shaft and a longitudinally extensive popliteal fossa. Therefore, it might represent a still unknown taxon from the upper portion of the *Hyperodapedon* Assemblage Zone in Southern Brazil.

Nesbitt *et al.* (2010) recognized an unnamed clade within Silesauridae, containing *Asilisaurus*, *Eucoelophysis*, *Sacisaurus*, and *Silesaurus* supported by about five

synapomorphies, including a popliteal fossa extending for proximally one-fourth to one-third the length of the femur, as observed in UNIPAMPA-0632. However, both the composition and phylogenetic position of Silesauridae have been recently considered uncertain (Langer and Ferigolo, 2013), hampering the precise taxonomic attribution of this specimen. Still, the absence of a protruding 'lesser trochanter' suggests a closer affinity to non-dinosaur Dinosauriformes, given that all well known Triassic dinosaurs have that structure (Nesbitt, 2011; Langer and Ferigolo, 2013).

The faunal content of the Janner, or Várzea do Agudo, site resembles that of the Ischigualasto Formation, in northwestern Argentina, which shows a predominance of both *Exaeretodon* (Cabrera, 1943) and *Hyperodapedon* (Huxley in Murchison, 1859; p. 435, 436; Huxley, 1869). [Note: The genus and species name *Hyperodapedon gordonii* was introduced by Sir Roderick I. Murchison in 1859, in a postscript added in press (see References in the present paper), the fossil having been sent by Murchison to T. H. Huxley for identification. Murchison therein attributed the name to Huxley. Consequently the genus should be cited as *Hyperodapedon* Huxley in Murchison, 1859, and likewise the type species *H. gordonii*.] This allows a direct biostratigraphic correlation and the proposition of a late Carnian age for the Janner Site (Martinez *et al.*, 2011). Because of the predominance of *Exaeret-*

*odon* specimens, Langer *et al.* (2007) assigned that locality to the upper portions of the *Hyperodapedon* Assemblage Zone, whereas the *Sacisaurus agudoensis* locality (also in the municipality of Agudo) belongs to the lower (upper Carnian/lower Norian) *Riograndia* Assemblage Zone (Soares *et al.*, 2011), within the Caturrita Formation. Accordingly, UNIPAMPA-0632 is probably older than *Sacisaurus agudoensis*. Indeed, if UNIPAMPA-0632 corresponds to a Silesauridae, it extends the occurrence of this clade to the Carnian of Brazil. In global terms, the only two other putatively Carnian silesaurids are *Diodorus scytobranchion* from the Timezgadiouine Formation, Morocco, and *Ignotosaurus fragilis* (Martínez *et al.*, 2013) from the Ichigualasto Formation, Argentina.

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### References

- Arcucci, A. B., 1987: Un nuevo Lagosuchidae (Thecodontia- Pseudosuchia) de la fauna de Los Chañares (edad reptil Chañarensis, Triásico Medio), La Rioja, Argentina. *Ameghiniana*, vol. 24, p. 89–94.
- Benton, M. J., 1985: Classification and phylogeny of the diapsid reptiles. *Zoological Journal of the Linnean Society*, vol. 84, p. 97–164.
- Cabreira, S. F., Schultz, C. L., Bittencourt, J. S., Soares, M. B., Fortier, D. C., Silva, L. R. and Langer, M. C., 2011: New stem-sauropodomorph (Dinosauria, Saurischia) from the Triassic of Brazil. *Naturwissenschaften*, vol. 98, p. 1035–1046.
- Cabrera, A., 1943: El primer hallazgo de terápsidos en la Argentina. *Notas del Museo de La Plata*, vol. 8, p. 317–331.
- Colbert, E. H., 1970: A saurischian dinosaur from the Triassic of Brazil. *American Museum Novitates*, no. 2405, p. 1–39.
- Cope, E. D., 1869: Synopsis of the extinct Batrachia, Reptilia and Aves of North America. *Transactions of the American Philosophical Society, New Series*, vol. 14, p. 1–252.
- Da-Rosa, A. A. S., Leal, L. A., Boelter, R. A. and Dambros, C. S., 2006: *Um novo Sauropodomorpha para o Triássico Superior do sul do Brasil*. Ciencia e Natura Edição Especial, Santa Maria, p. 31.
- Dzik, J., 2003: A beaked herbivorous archosaur with dinosaur affinities from the early Late Triassic of Poland. *Journal of Vertebrate Paleontology*, vol. 23, p. 556–574.
- Ezcurra, M. D., 2006: A review of the systematic position of the dinosauriform archosaur *Eucoelophysis baldwini* Sullivan & Lucas, 1999 from the Upper Triassic of New Mexico, USA. *Geodiversitas*, vol. 28, p. 649–684.
- Ezcurra, M. D., 2012: Comments on the taxonomic diversity and paleobiogeography of the earliest known dinosaur assemblages (late Carnian-earliest Norian). *Historia Natural, Tercera Serie*, vol. 2, p. 49–71.
- Ferigolo, J. and Langer, M. C., 2007: A Late Triassic dinosauriform from south Brazil and the origin of the ornithischian predatory bone. *Historical Biology*, vol. 19, p. 23–33.
- Gauthier, J. A., 1986: Saurischian monophyly and the origin of birds. *Memoirs of the California Academy of Sciences*, vol. 8, p. 1–55.
- Huxley, T. H., 1869: *On Hyperodapedon*. Quarterly Journal of the Geological Society of London, vol. 25, p. 138–152.
- Irmis, R. B., 2011: Evaluating hypotheses for the early diversification of dinosaurs. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, vol. 101, p. 397–426.
- Kammerer, C. F., Nesbitt, S. J. and Shubin, N. H., 2012: The first silesaurid dinosauriform from the Late Triassic of Morocco. *Acta Palaeontologica Polonica*, vol. 57, p. 277–284.
- Kischlat, E., 1999: A new dinosaurian “rescued” from the Brazilian Triassic: *Teyuwasu barbarenae*, new taxon. *Paleontologia em Destaque, Boletim Informativo da Sociedade Brasileira de Paleontologia*, vol. 14, p. 58.
- Langer, M. C., 2004: Basal saurischians. In, Weishampel, D. B., Dodson, P. and Osmólska, H. eds., *The Dinosauria. Second Edition*, p. 25–46. University of California Press, Berkeley.
- Langer, M. C., Abdala, F., Richter, M. and Benton, M. J., 1999: A sauropodomorph dinosaur from the Upper Triassic (Carman) of southern Brazil. *Comptes Rendus de l’Académie des Sciences, Série IIA*, vol. 329, p. 511–517.
- Langer, M. C., Ezcurra, M. D., Bittencourt, J. S. and Novas, F. E., 2010: The origin and early evolution of dinosaurs. *Biological Reviews*, vol. 85, p. 55–110.
- Langer, M. C. and Ferigolo, J., 2013: The Late Triassic dinosauriform *Sacisaurus agudoensis* (Caturrita Formation; Rio Grande do Sul, Brazil): anatomy and affinities. In, Nesbitt, S. J., Desojo, J. B. and Irmis, R. B. eds., *Anatomy, Phylogeny and Palaeobiology of Early Archosaurs and their Kin*, p. 353–392. Geological Society, Special Publications, vol. 379. The Geological Society, London.
- Langer, M. C., Nesbitt, S. J., Bittencourt, J. S. and Irmis, R. B., 2013: Non-dinosaurian Dinosauriforms. In, Nesbitt, S. J., Desojo, J. B. and Irmis, R. B. eds., *Anatomy, Phylogeny and Palaeobiology of Early Archosaurs and their Kin*, p. 157–186. Geological Society, Special Publications, vol. 379. The Geological Society, London.
- Langer, M. C., Ribeiro, A. M., Schultz, C. L. and Ferigolo, J., 2007: The continental tetrapod-bearing Triassic of south Brazil. In, Lucas, S. G. and Spielman, J. A. eds., *The Global Triassic. New Mexico Museum of Natural History and Science Bulletin*, vol. 41, p. 201–218.
- Martínez, R. N., Apaldetti, C., Alcober, O. A., Colombi, C. E., Sereno, P. C., Fernandez, E., Santi Malnis, P., Correa, G. A. and Abelin, D., 2013: Vertebrate succession in the Ichigualasto Formation. *Journal of Vertebrate Paleontology*, vol. 31, p. 10–30.
- Martínez, R. N., Sereno, P. C., Alcober, O. A., Colombi, C. E., Renne, P. R., Montañez, I. P. and Currie, B. S., 2011: A basal dinosaur from the dawn of the dinosaur era in southwestern Pangaea. *Science*, vol. 331, p. 206–210.
- Murchison, R. I., 1859: *On the sandstones of Morayshire (Elgin &c.) containing reptile remains; and on their relations to the Old Red Sandstone of that country*, Quarterly Journal of the Geological Society of London, vol. 15, p. 419–439.
- Nesbitt, S. J., 2011: The early evolution of Archosauria: relationships and the origin of major clades. *Bulletin of the American Museum of Natural History*, vol. 352, p. 1–292.
- Nesbitt, S. J., Sidor, C. A., Irmis, R. B., Angielczyk, K. D., Smith, R.

- M. H. and Tsuji, L. A., 2010: Ecologically distinct dinosaurian sister group demonstrates early diversification of Ornithodira. *Nature*, vol. 464, p. 95–98.
- Novas, F. E., 1992: Phylogenetic relationships of the basal dinosaurs, the Herrerasauridae. *Palaeontology*, vol. 35, p. 51–62.
- Novas, F. E. and Ezcurra, M. D., 2005: The evolutionary radiation of Triassic dinosauriforms. *Ameghiniana*, vol. 42, p. 36.
- Novas, F. E., Ezcurra, M. D., Chatterjee, S. and Kuttly, T. S., 2011: New dinosaur species from the Upper Triassic Upper Maleri and Lower Dharmaram formations of Central India. *Earth and Environmental Science Transactions of the Royal Society of Edinburgh*, vol. 101, p. 333–349.
- Romer, A. S., 1972a: The Chañares (Argentina) Triassic reptile fauna. XIV. *Lewisuchus admixtus* a further thecodont from the Chamares Bed. *Breviora*, vol. 390, p. 1–13.
- Romer, A. S., 1972b: The Chañares (Argentina) Triassic reptile fauna. XV. Further remains of the thecodonts *Lagerpeton* and *Lagosuchus*. *Breviora*, vol. 390, p. 1–7.
- Sereno, P. C. and Arcucci, A. B., 1993: Dinosaurian precursors from the Middle Triassic of Argentina: *Lagerpeton chanarensis*. *Journal of Vertebrate Paleontology*, vol. 13, p. 385–399.
- Soares, M. B., Schultz, C. L. and Horn, B. L. D., 2011: New information on *Riograndia guaibensis* Bonaparte, Ferigolo & Ribeiro, 2001 (Eucynodontia, Trithelodontidae) from the Late Triassic of southern Brazil: anatomical and biostratigraphic implications. *Annals of the Brazilian Academy of Sciences*, vol. 83, p. 329–354.
- Sullivan, R. M. and Lucas, S. G., 1999: *Eucoelophysis baldwini*, a new theropod dinosaur from the Upper Triassic of New Mexico, and the status of the original types of *Coelophysis*. *Journal of Vertebrate Paleontology*, vol. 19, p. 81–90.